INTEGRATED OCEAN OBSERVING SYSTEM

IOOS®

INTEGRATED OCEAN OBSERVING SYSTEM

Our Eyes on the Oceans Coasts and Great Lakes

USACE Coastal Engineering Research Board

Zdenka Willis

IOOS

What is the U.S. Integrated Ocean Observing System?

A tool that will enable the Nation to track, predict, manage and adapt to changes in our marine environment and deliver critical information to decision makers to…

Improve safety

Enhance our economy

Protect our environment

US IOOS: a National Endeavor

Federal Players

IOOS INTEGRATED OCEAN OBSERVING SYSTEM

=

NOAA · DEPARTMENT OF THE NAVY ONR Science & Technology · NASA · NATIONAL SCIENCE FOUNDATION · USGS · Marine Mammal Commission

But Part of a Global Framew

IOOS INTEGRATED OCEAN OBSERVING SYSTEM → GOOS → GEOSS

Global Ocean Observing Syst

And Extends to a Regional Level

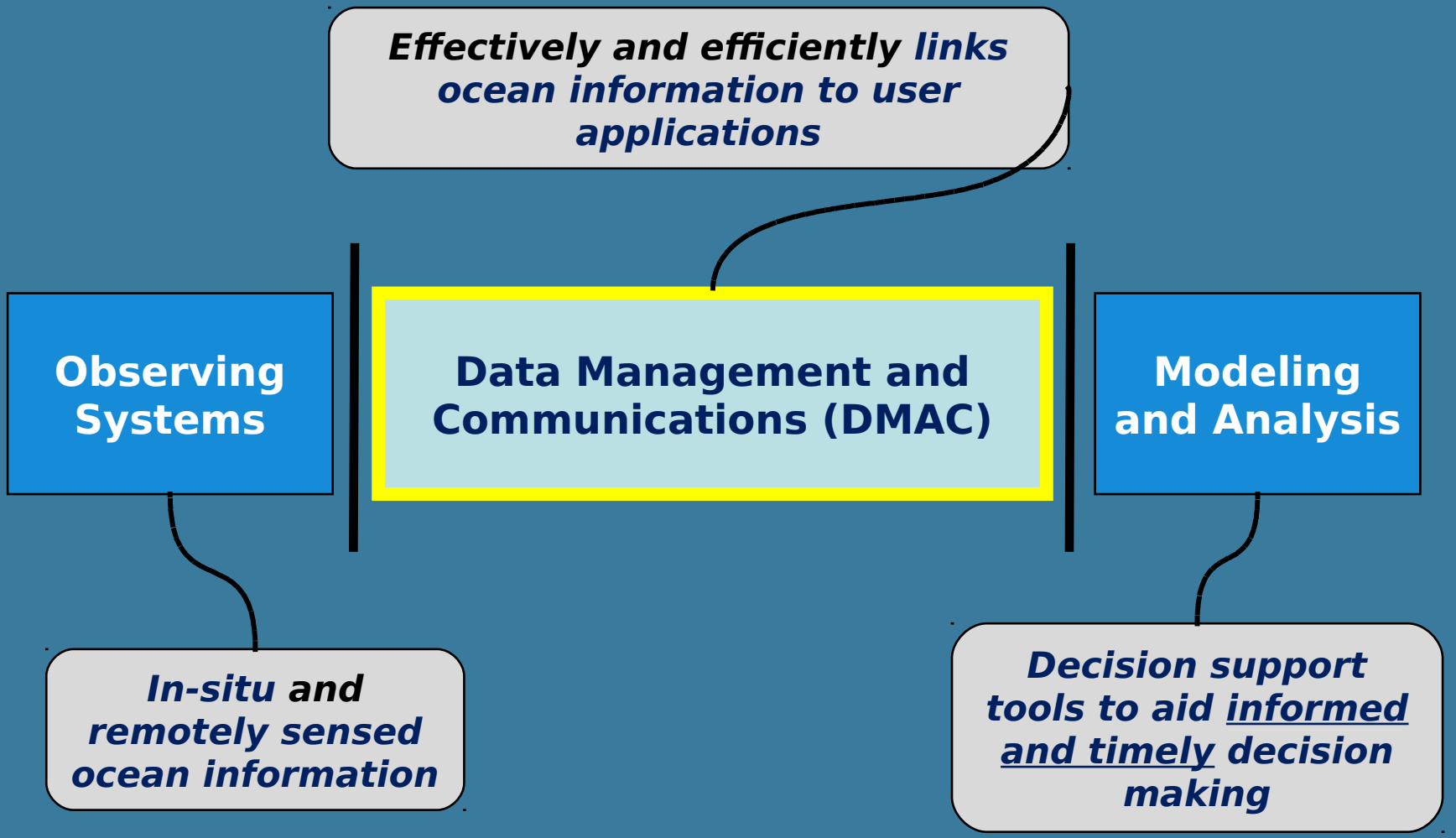
IOOS Regional Component

A network of 11 regional coastal ocean observing systems that meet national and regional needs for local ocean observations, data

- Meeting National missions through…
  - Expanded observations and modeling capacity
  - Connections to users and stakeholders
  - Implementation of national data standards
  - Products transitioned to other regions and to National operations
  - Sensor validation/verification

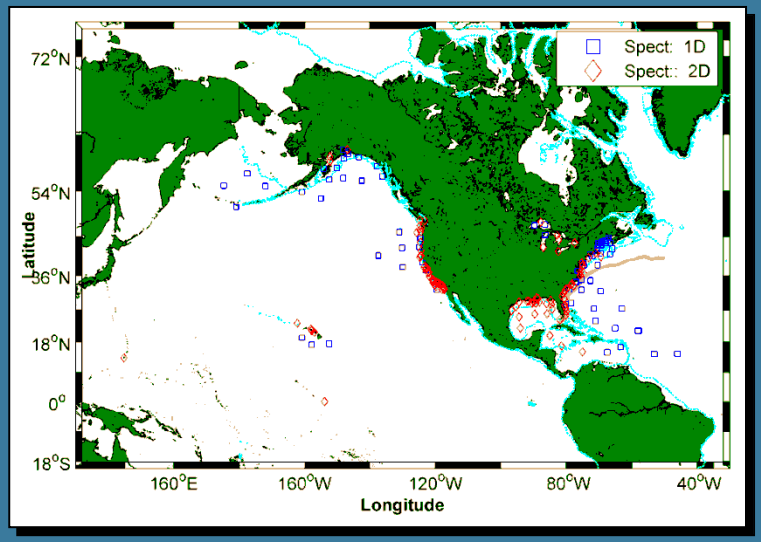
1. **Alaska Ocean Observing Systems (AOOS)**
2. **Caribbean Regional Association (CaRA)**
3. **Central and Northern California Coastal Ocean Observing System (CeNCOOS)**
4. **Gulf Coastal Ocean Observing System (GCOOS)**
5. **Great Lakes Observing System (GLOS)**
6. **Mid-Atlantic Coastal Ocean Observing System Regional Association (MACOORA)**
7. **Northwest Association of Networked Ocean Observing Systems (NANOOS)**
8. **Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS)**
9. **Pacific Islands Ocean Observing System (PacIOOS)**
10. **Southern California Coastal Ocean Observing System (SCCOOS)**
11. **Southeast Coastal Ocean Observing System Regional Association (SECOORA)**
12. **Alliance for Coastal Technologies (ACT) {Sensor V & V}**

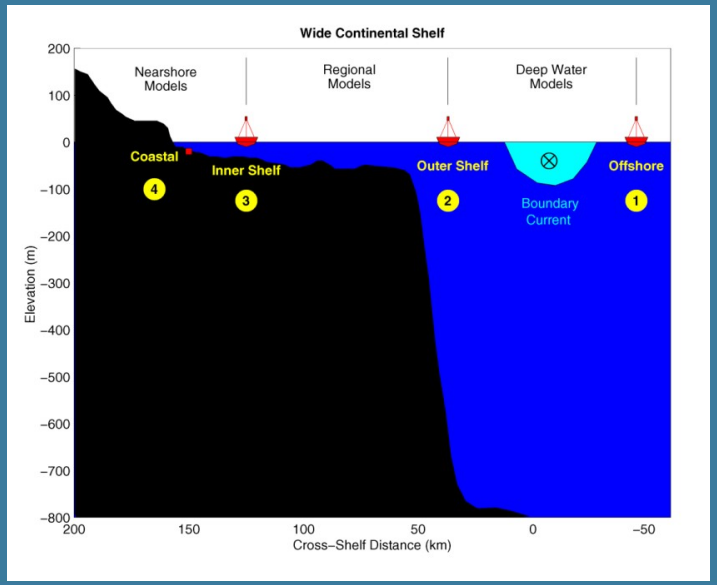
Background: IOOS® Subsystems


Effectively and efficiently links ocean information to user applications
Observing Systems
Data Management and Communications (DMAC)
Modeling and Analysis
In-situ and remotely sensed ocean information
Decision support tools to aid informed and timely decision making

Observations: National Operational Wave Plan

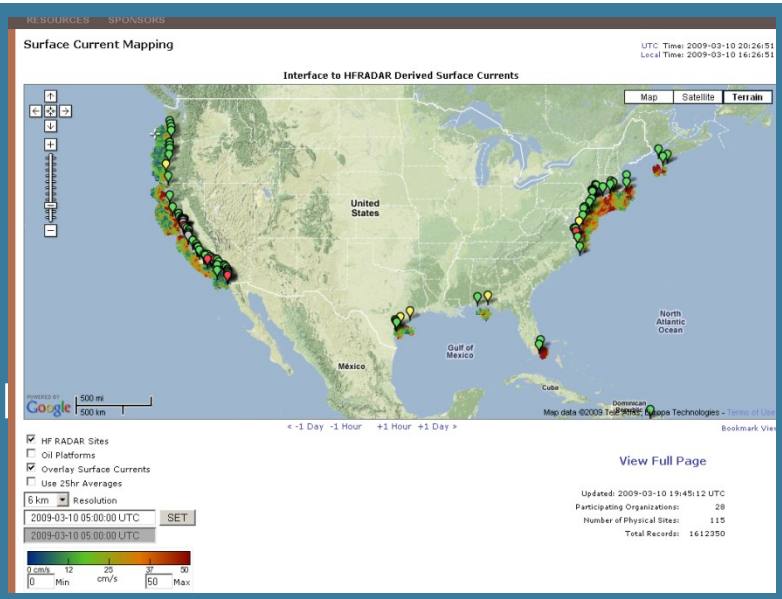
- Collaboration led by USACE
- 181 locations exist, 115 new, 128 upgrades
- Incorporation into PORTS®
- Serves broad range of wave information users
- Comprehensive system design
- USACE responsible for coastal sites (expansion of Field Wave Gauging program); NOAA the deeper locations; both agencies support the infrastructure



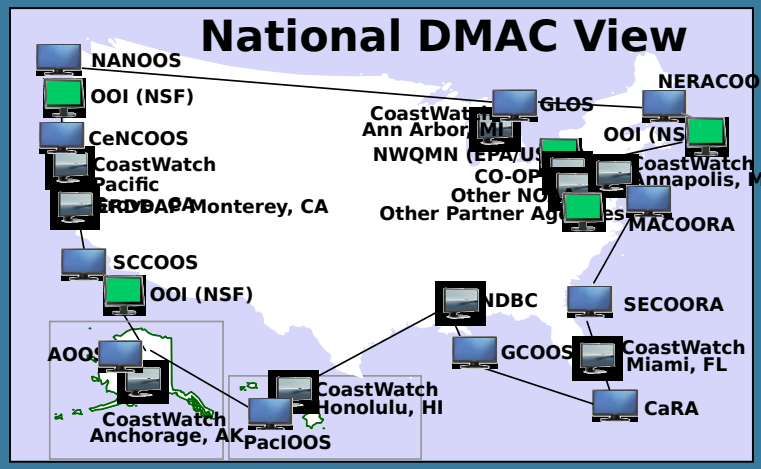


Observations: Surface Currents

- ~110 High Frequency Radars
- Frequency/Location
- Data Management
- Uses: Currents tables; Search a
  Rescue; Beach Closure; HAB
  - Coast Guard using in operational SAROPS
- National Plan: in second review
- Challenges: gaps in coverage; gap filling for data; additional quality control of data; extend short-term capability nationwic



Data Management and Communications

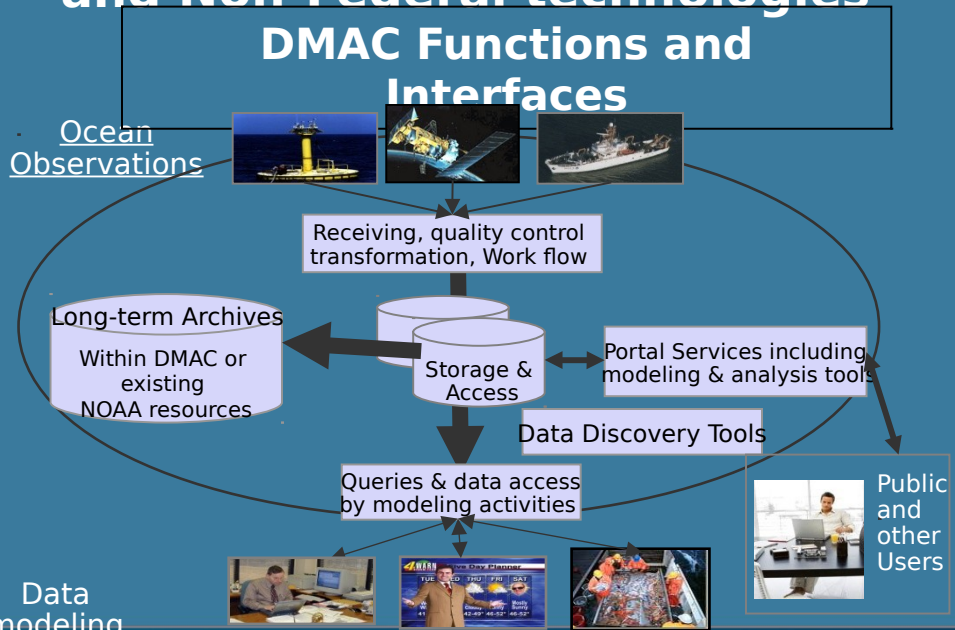


Overview

- Distributed Regional & Federal Data Assembly Centers
- Develops and manages technical design & standards
- Leverages existing Federal and Non-Federal technologies

Functionality

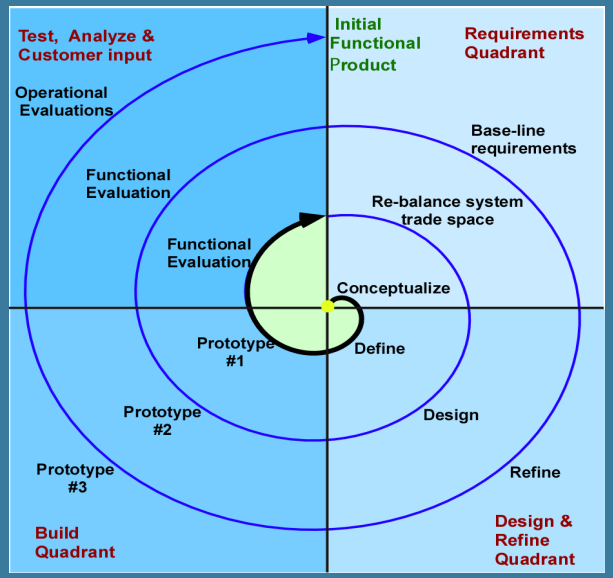
- Integrated data #1 request
- Standardize, integrate, and simplify delivery of data from multiple sources
- Access to broader data resources to understand impacts of climate change and improved management decisions


DMAC Functions and Interfaces
Ocean Observations
Receiving, quality control transformation, Work flow
Long-term Archives
Within DMAC or existing NOAA resources
Storage & Access
Portal Services including modeling & analysis tools
Data Discovery Tools
Queries & data access by modeling activities
Public and other Users
Data modeling and products

Data Integration Framework (DIF)

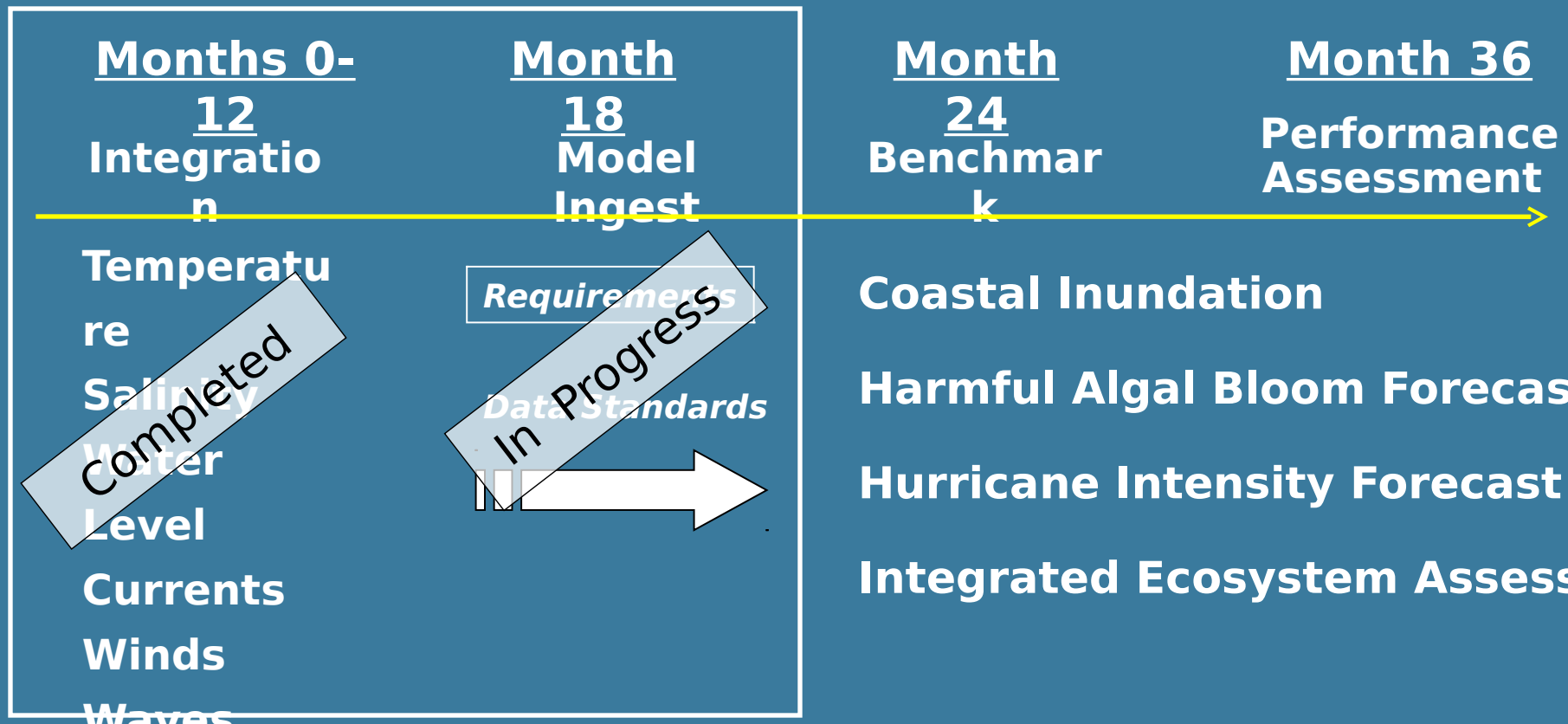
- Began as pilot project (2007-2010)
  - First spiral of IOOS development
  - Evaluate benefit in 2010
- Limited scope for reduced risk
  - Implement at 3 provider and 4 customer sites
  - Start with 7 core variables
    - Currents, Temperature, Salinity, Water Level, Winds, Waves, Ocean Color (chlorophyll)
- Systems engineering documents

  Available at http://ioos.noaa.gov/dif/
  - Concept of Operations
  - Functional Requirements
  - Design



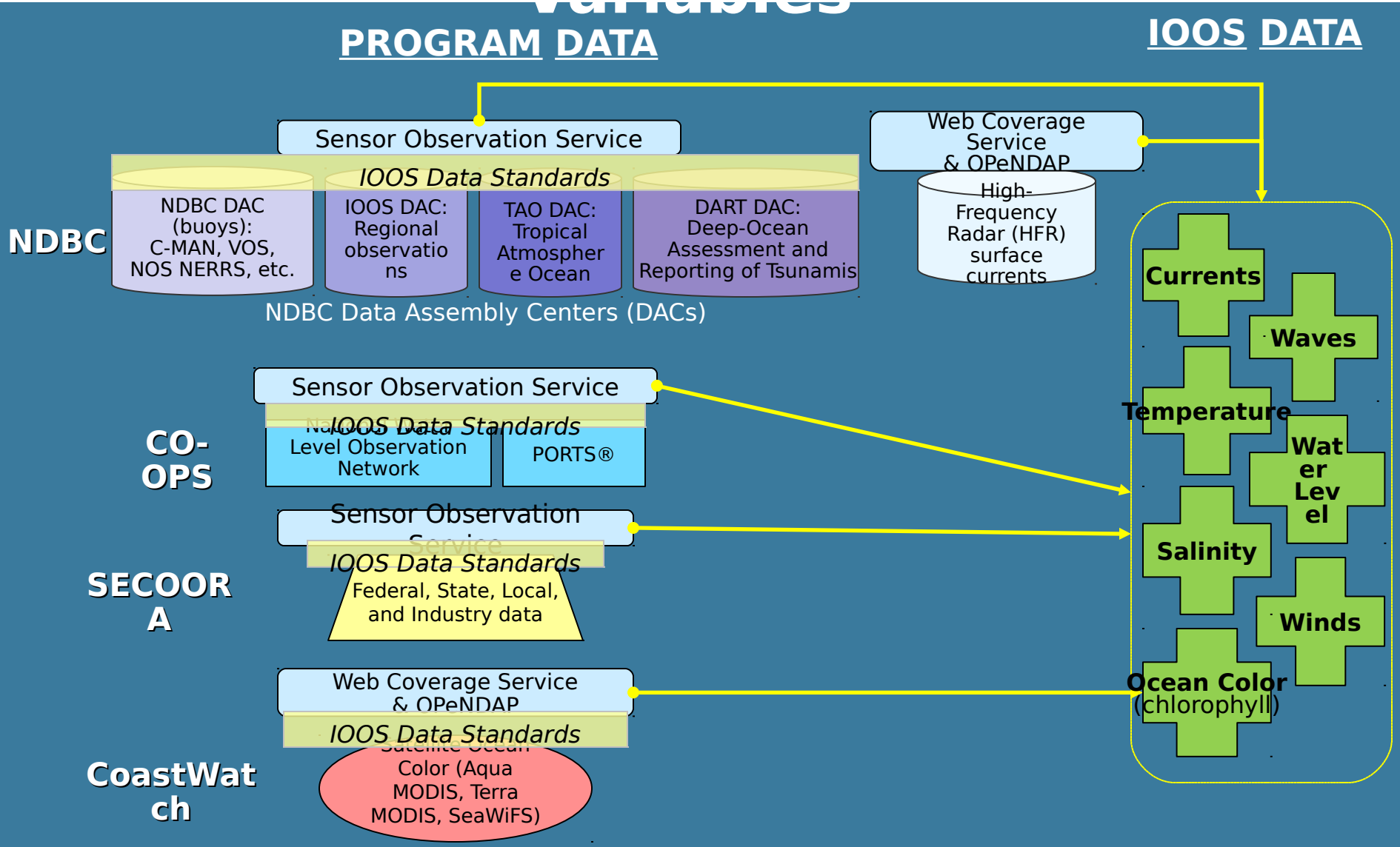
(Graphic by i3 Aerospace Technologies Pty Ltd – used with permission)

Data Integration Framework

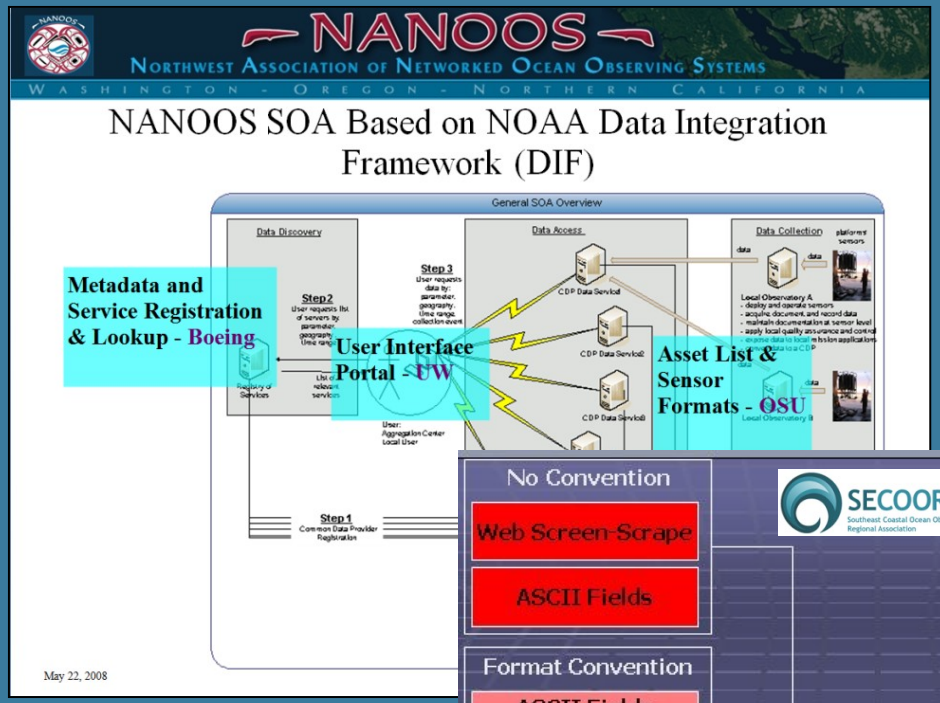


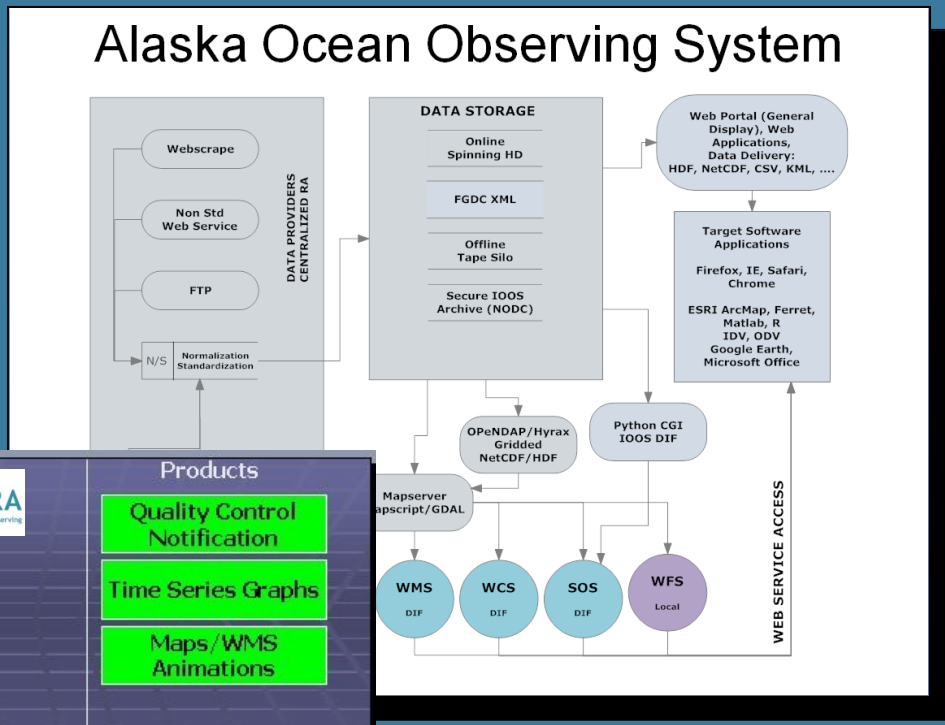
- Regional Implementation of the DIF
- Interagency/GEOSS data management collaborations
- Documents at www.ioos.noaa.gov

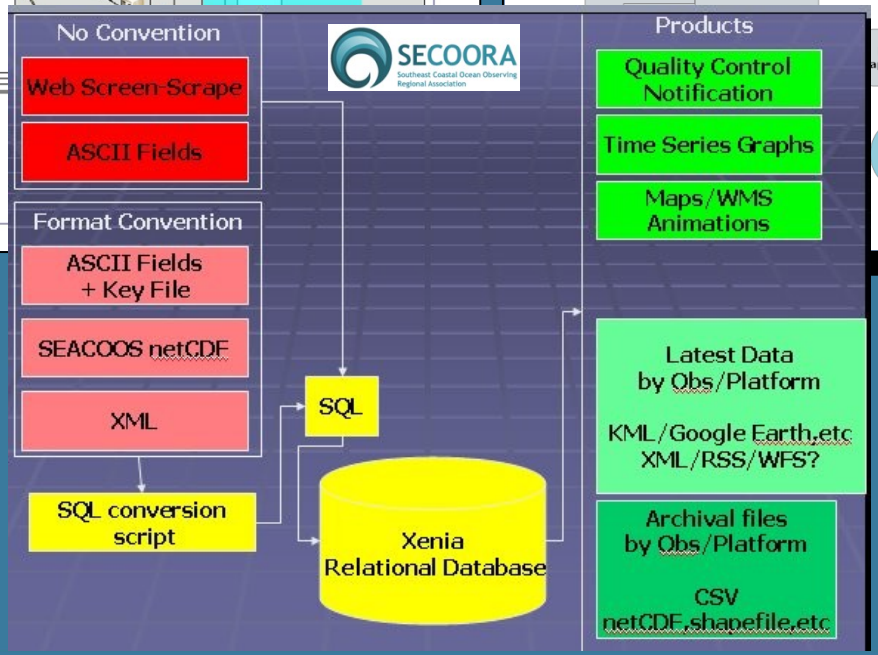
Integration of Data Variables



DMAC Regional Architecture

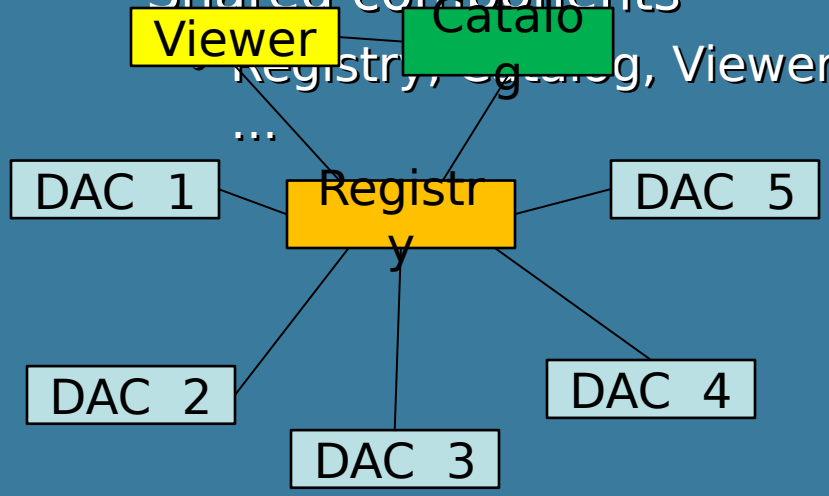

NANOOS
Northwest Association of Networked Ocean Observing Systems
Washington - Oregon - Northern California
NANOOS SOA Based on NOAA Data Integration Framework (DIF)
General SOA Overview
Data Discovery
Data Access
Data Collection
Metadata and Service Registration & Lookup - Boeing
User Interface Portal - UW
Asset List & Sensor Formats - OSU
May 22, 2008





Federated, Service-Oriented Architecture

- ✓ Federated
  - Several Data Assembly Centers
    - Each supports particular Organization, Region, Theme,...
    - Standardized service interfaces
  - Shared components
    - Registry, Catalog, Viewer, ...



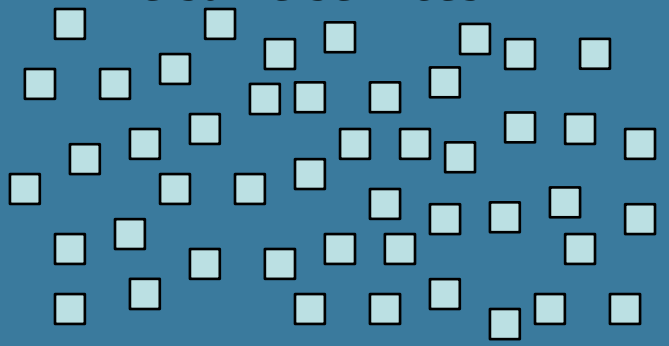
- ✗ *Monolithic*
  - *All data in single warehouse*
  - *All services provided by*

Global DAC

Viewer | Registry | Catalog

Midway between these extremes

- ✗ *Fully distributed*
  - *Every data provider adopts the same services*



DMAC Next Steps

- High Level Functional Requirements; CONOPS
- IOOS Industry Day: March 12, 2009
  - IOOS DMAC briefs from: NOAA, Navy, US Army Corps of Engineers, US Geological Survey, US Environmental Protection Agency
- “Request for Information”: 16 Responses Received
- Meet with candidate vendors as needed for more information
- Analysis of Alternatives – late summer
- Implementation of DIF within Regions
- Discussions with Google

IOOS Regions Supporting IOOS Missions

Transportation/ Homeland Security

- Surface current data from >100 High Frequency Radar stations
- Improved tools for port pilots and ships entering major harbors
- High-resolution coastal mapping (funded by CA and Pacific NW) to NOAA standards
- Oil spill trajectory tracking (Cosco Busan)
- Delivering models of nearshore waves

Ecosystems and Oceans Human Health

- Larval Sampling
- Harmful Algal Bloom monitoring: 4 RAs
- IEA data collection and support: 4 RAs
- Benthic habitat and species mapping (NEBO)
- Extension of CalCOFI transects
- Fisheries stock information and products support recreational and commercial fishing: 4 RAs
- Aquaculture: Data/products for shellfish growers (northwest), abalone (CA), lobster (northeast)

Climate

- Coastal observations to monitor *local* impacts of global climate change
- Observations and data support state/CZM climate change adaptation plans:
  - LiDAR collection for hi-res topography
  - State Sea Level Rise plans (2 RAs)
  - Lead PI for 5-year NSF climate project
- Coastal Inundation modeling projects (4)

Natural Hazards/Weather Prediction

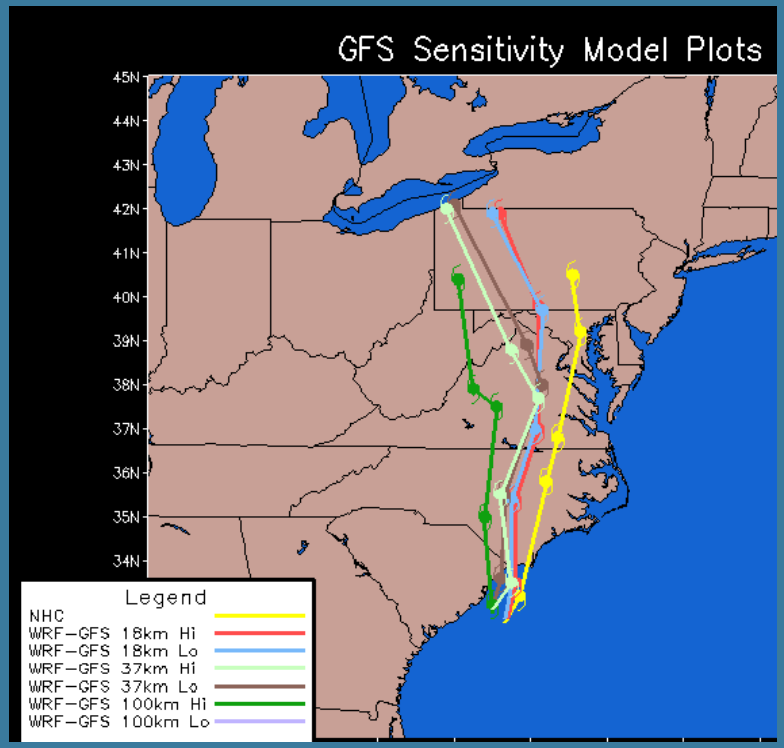
- SE Marine Weather Portal – **single** site for marine weather data
- Providing data and products to WFOs:
  - New York City; Philadelphia; Boston; Wakefield, VA; Newport & Wilmington, NC; Honolulu, HI; and San Juan, PR
- Water Quality projects: 4 RAs

Sensor Validation and Verification Services

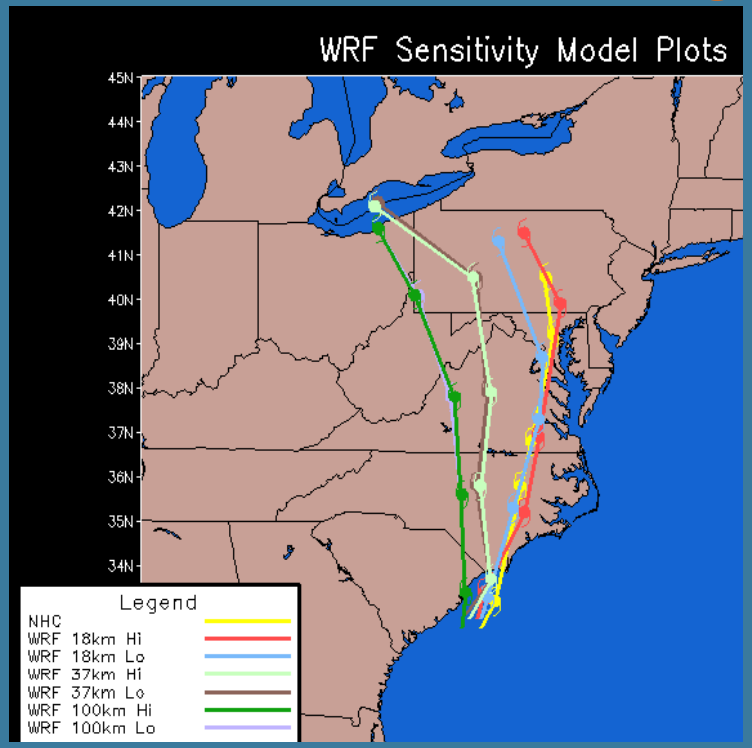
MACOORA In Action

Hurricane Ernesto: Labor Day Weekend 2006

Operational Model
Observed Track in Yellow

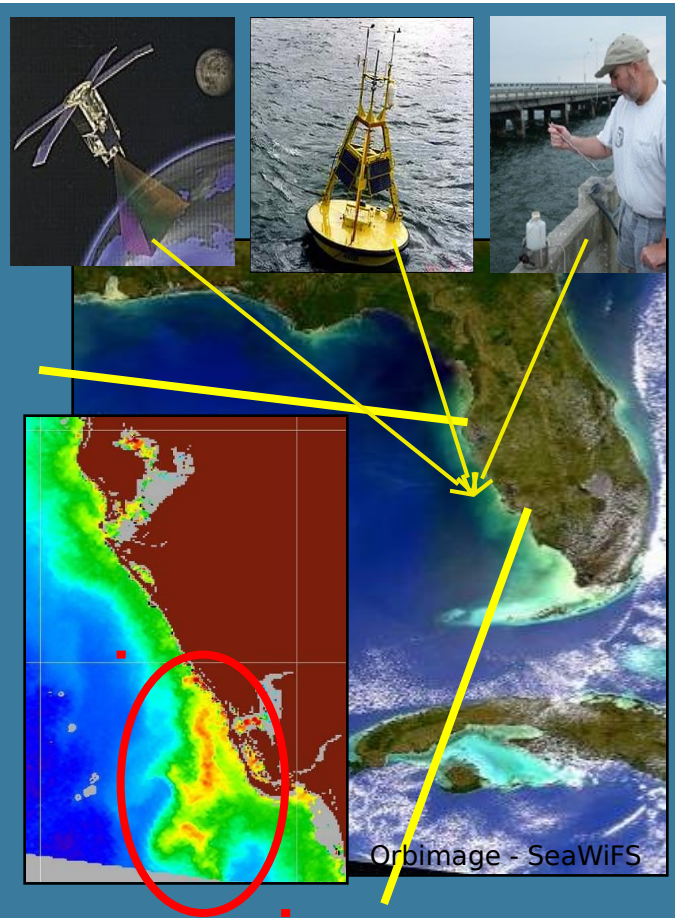


Research Model
Predicted Track in Orange



Model Skill improved when taking into account Ocean-Atmosphere Interactions

Reduce Public Health Risks



Increasing warning of harmful algal blooms (HABs) increases the options for managing these events

Pollutants from storm water runoff can result in public beach closures

SCCOOS – Los Angeles/Long Beach Project

COASTAL DATA INFORMATION PROGRAM

- Based at Scripps since 1975
- 35 Wave Stations
- 14 People
- $2.5M+ / year budget
- Funded by: USACE, CDBW (SCCOOS, BEACON, ONR…)

CALIFORNIA OCEAN CURRENTS MONITORING Program

- Based at Scripps since 2004
- $21M initial funding
- Funded by:

Coastal Conservancy

Statewide Program

Real Time & Forecast Information

Site SP001 - info
San Pedro Harbor
Site 001

Data Tables
- Parameter
- 9-band energy
- 9-band direction

Daily & Weekly Plots
- Waves - 1 day
- Waves - 1 week
- Wave forecast

Simulated Time Series
- Z displacement values
- Z displacement plot

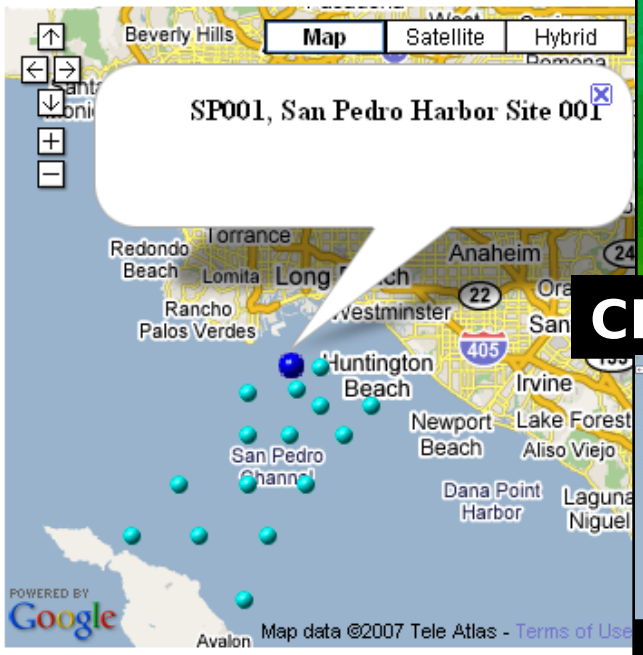
Latest Model Run
- 9-band plot
- Spectral plot
- Directional spectrum
- Spectral file

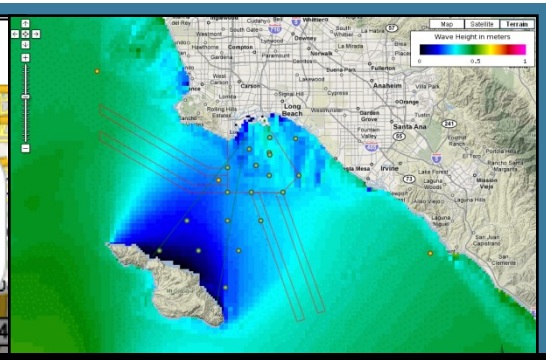
Descriptions/Help

Summary Table
Location Map

Site ID: SP001

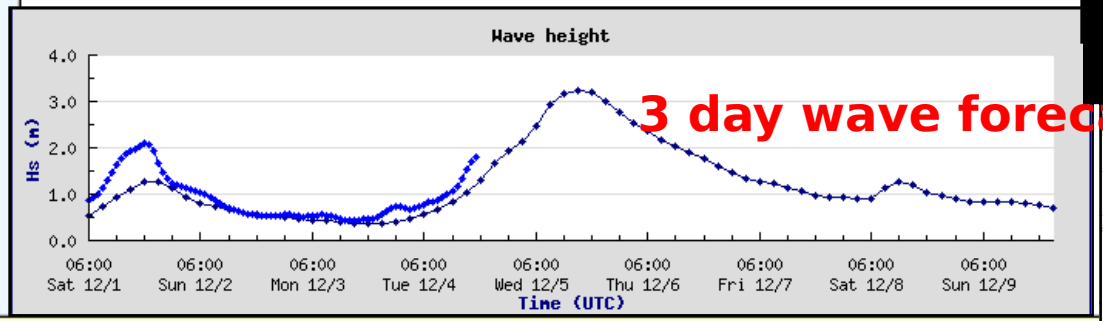
- Location:
  33 41.10 N 118 14.22 W
  (33.6850 -118.2370)
- Water depth:
  999.9 m (3281 ft, 547 fm)
- Modeled parameters:
  wave energy, wave direction



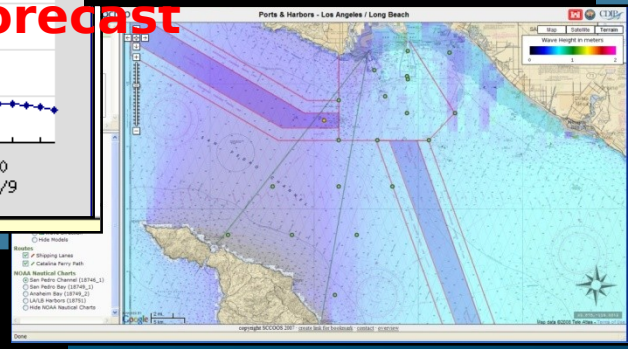


CDIP provides wave

SCCOOS provides currents



3 day wave forecast



NOAA Charts on Google

Automated notification when thresholds are exceeded!

Coastal Inundation

COMMUNITY INVOLMENT: What do customers need to know?

PRODUCT DESIGN

SOCIAL SCIENCE:
Risk Assessment
Decision Making

VISUALIZATION TOOLS

INTEGRATED DISSEMINATION AND TRAINING

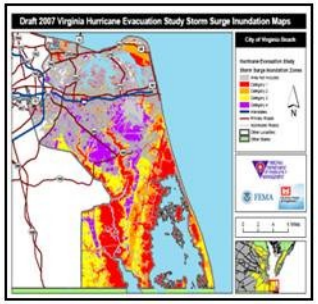
One Stop Shopping
for NOAA Information and Tools

NOAA Products Integrated:
With Google Ocean, Media, Other Agencies

Training and Feedback:
Awareness, Refinement, Lessons Learned

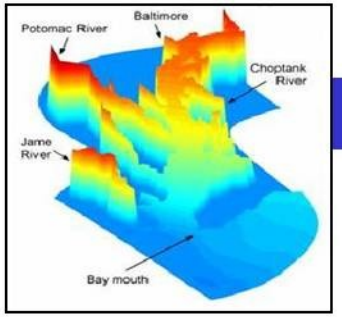
OBS & MODELING

Monitoring, Validation and Post Storm Analysis



High Res Bathymetry and Topography

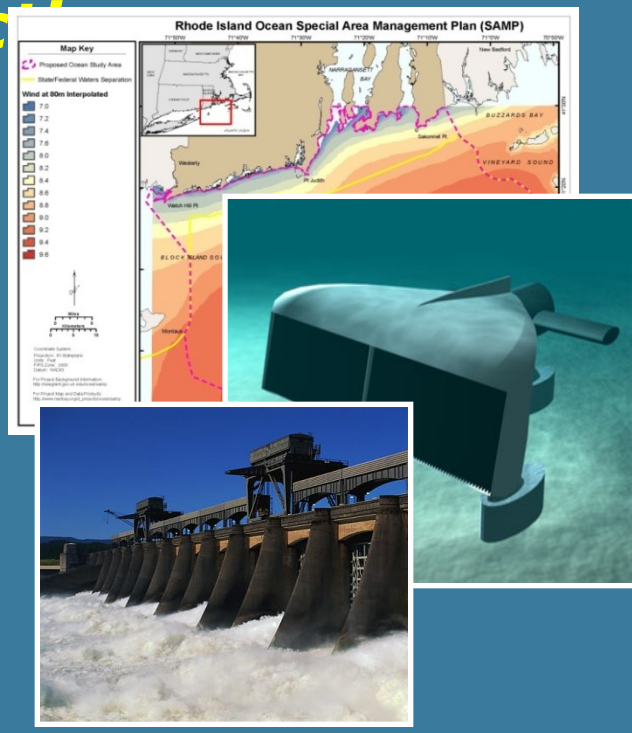
Data Integration and Assimilation



MODELING SYSTEM: Hurricane, Weather, Tide, Wave, Surge, Hydrologic
Uncertainty Tools: Ensembles, Statistical Probabilities

Emerging Needs: Energy/Climate

- ***Pre –Construction – Post Construc***
  - Avian Studies
  - Geophysical Investigations
  - Geotechnical Investigations
  - Met Tower Installation
  - Wave Sensor Deployment
  - Staging Port Development
  - Foundation Installation
  - Sub-sea Electrical Cable Installation
  - Offshore Substation Installation
  - Turbine Installation
  - O&M Activities
  - Decommissioning



- ***Climate***
  - ***L*ong-term, sustained data records needed to monitor effects of a changing climate**
  - **IOOS regional data and services complement federal capacity**
  - **Regions support science-based, climate change mitigation plans at the state level**

Interagency Interactions

- NOAA chairs the Interagency Working Group on Ocean Observations; NOAA IOOS provides NOAA Rep
- National Water Quality Monitoring Network (NOAA, EPA, & USGS)
- Census of Marine Life: Sharing data standards with Ocean Biogeographic Information System (NOAA, USGS)
- Ocean Observatories Initiative (NOAA, NSF)
- Integrated Ocean and Coastal Mapping (NOAA, USACE, USGS)
- Marine Protected Areas FAC, statement on IOOS (NOAA, DOI)
- GEOSS: NOAA participation on two US-GEO Working Groups; DIF activities registered
- DHS – Maritime Domain Awareness Centers of Excellence

Legislation Opportunities for Invovlement

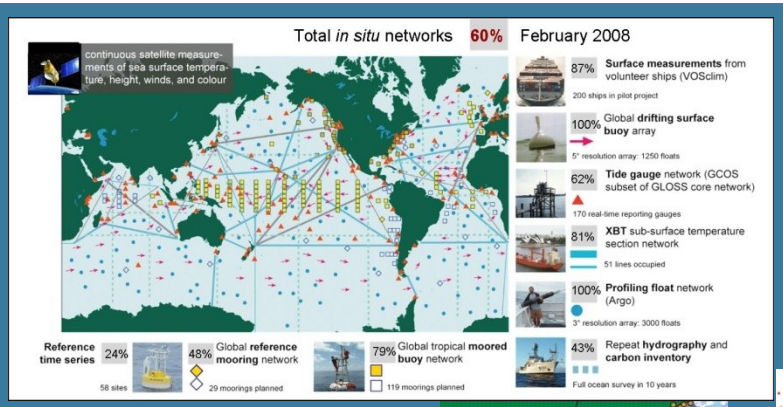
- **Opportunities:**
  - Establish an IOOS Program Office utilizing interagency staff
  - Establish observation variables and priorities
  - Implement DMAC
  - Establishes Regional Coordination Entities (RICE)/Civil Liability
    - Feds can now serve on the boards
  - Establish a System Advisory Committee
- **Near-term Deadlines:**
  - September 09: Develop Public/Private Use Policy
  - March 2010: Obtain an independent cost estimate
  - Provide annual coordinated, comprehensive budget requests to Congress

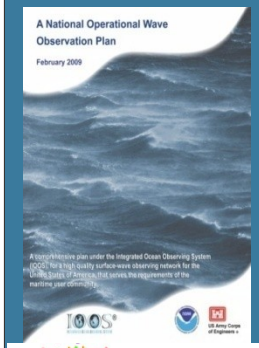
Industry Outreach

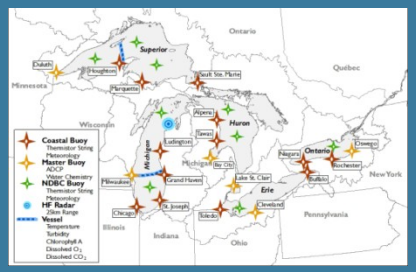
- Goal - How does IOOS benefit these industries
- 4 Planned:
  - 14 April D.C
  - Houston (in work)
  - Great Lakes (in work)
  - Copenhagen 14 Oct 09

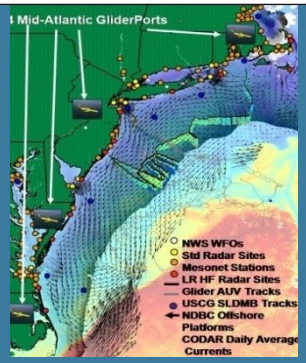
IOOS®
INTEGRATED OCEAN OBSERVING SYSTEM
Small Sea Changes:
Big Business Impacts
Early registration for the event is highly recommended
For more information visit: www.oceanleadership.org/iwgoo
This workshop is sponsored and organized by the Interagency Working Group on Ocean Observations and the organizations represented below:
NOAA
IMAREST
Ocean Leadership
SAIC
From Science to Solutions
A workshop to explore how enhanced understanding of the oceans improves weather and climate prediction enabling better informed business decisions.
Tuesday April 14th 2009
Silver Spring, Maryland
Delegates will attend from the following sectors:
• Agriculture • Energy • Health Care • Manufacturing • Tourism
• Aviation • Finance • Insurance • Mining • Transportation
• Construction • Fishing & Aquaculture • Leisure • Retail • Utilities

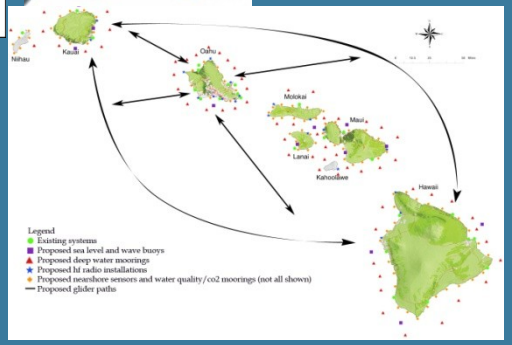
Completing the Plan

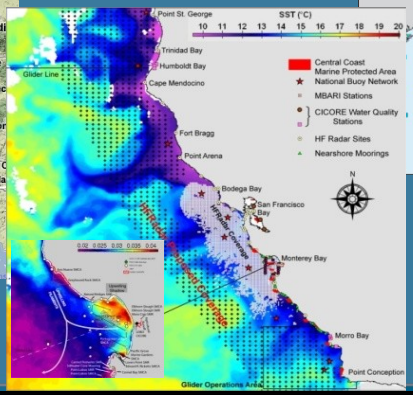

Total *in situ* networks 60% February 2008
continuous satellite measurements of sea surface temperature, height, winds, and colour
87% Surface measurements from volunteer ships (VOSclim)
200 ships in pilot project
100% Global drifting surface buoy array
5° resolution array: 1250 floats
62% Tide gauge network (GCOS subset of GLOSS core network)
170 real-time reporting gauges
81% XBT sub-surface temperature section network
51 lines occupied
100% Profiling float network (Argo)
3° resolution array: 3000 floats
43% Repeat hydrography and carbon inventory
Full ocean survey in 10 years
Reference time series 24%
58 sites
48% Global reference mooring network
29 moorings planned
79% Global tropical moored buoy network
119 moorings planned

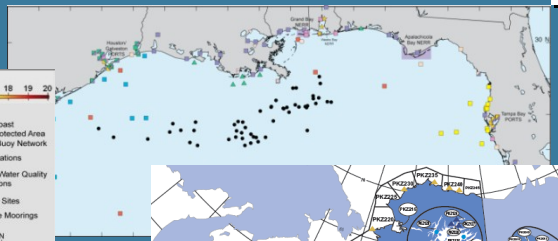












Coastal Observations need cleaner definition

IOOS® Imperative

- IOOS is a means of delivering data to multiple value added service providers
- Value added providers merge with other data/information to deliver customized products satisfying specific industry needs

Questions?

“Providing information needed to improve safety, enhance our economy and protect our environment”

http://ioos.noaa.gov